questionably a fad at present. It is true it can do some things, but it cannot do all. Our physiotherapeutic agents are massage, active and passive motions, either manual or with machine, constant traction, moist and dry heat, electricity, light, and passive hyperaemia. In a few of the conditions above mentioned we have indications for operation.

In bone injuries early passive motion and massage unquestionably help. They produce muscle tone and prevent annoying oedema. In the treatment of arthritis the therapy must be directed against the cause. The other means, heat, massage, passive congestion, etc., may make the patient feel better for an hour or two, but they make no permanent change in the joints themselves.

In the first type of muscle change, that is, scar following fracture, especially in fracture of the femur, perhaps a little can be done by using the force on the leg to bend the knee, but after the first bend is made the patient will do most of the loosening by the use of his own muscles. In the second type, the shortened normal muscle, a great deal can be done by passive motion. The muscle yields readily to stretching. In most instances it takes but a few motions if the opponents are in good condition. I wish to emphasize here the fact that fixation of a normal joint does not cause ankylosis. There is nothing in a normal joint that can cause union between the two bones, no matter how long they be held together. If the joint is the seat of a chronic arthritis, there may be bony interlocking or even bony union. In the third condition, muscle degeneration, constant traction is the only thing that does any good.

To loosen scar tissue in skin or fascia by massage, or any other form of physiotherapy, is, I believe, hopeless. The skin about the scar may be loosened, but not the scar itself. It is hopeless also to attempt to free adherent tendons in this manner. Suppurative tendon sheath infections should be opened by multiple lateral incisions and then the constriction bandage should be applied above the affected part for 20 to 22 hours a day. In the treatment of nerve injuries the essential thing, of course, is to re-establish and maintain a continuity of the nerve. This done and the extremity maintained in its physiologic position all is done that can be done until the nerve grows down. It does no good to massage or electrify a muscle without a nerve. If there is not an actual paralysis, but merely paresis, then massage and electricity may help.

In going over case records and in questioning enthusiastic physiotherapy aids, I have been struck by the fact that physiotherapy as at present applied and, shall I say, misapplied, does good in early fracture cases and practically in this group of cases only. We have all seen enthusiastic attempts to do this, that and the other by means of physiotherapy, but when we sit down and cold-bloodedly study the records, the limitations of this form of treatment become more and more apparent. It is for careful and unbiased observation of results that I would ask.

RECENT DEVELOPMENTS IN RADIUM THERAPY.*

By REX DUNCAN, M. D., Los Angeles.

The past five years have seen great advancement in radium therapy equal to, if not greater than that of any other branch of medicine. This has resulted not so much from our increased knowledge of the physical properties of radium, as from the better application of this knowledge and more particularly from a careful study and better understanding of the histological changes produced in both normal and abnormal tissues.

Improved technique, or I might say, an entirely new technique has developed from the use of radium emanation and has greatly broadened the scope of radium therapy.

While it is my purpose to call attention to the more recent developments in radium therapy, I wish to emphasize the fact that radium is not an agent to be used indiscriminately; each case must be thoroughly and individually studied and radium therapy employed only when alone or in combination with some other form of treatment, results are offered superior to those otherwise obtainable.

Inasmuch as all modern work with radium must necessarily imply the use of radium emanation, I wish briefly to refer more in detail to it.

Radium is an element which owes its therapeutic properties to certain rays emitted during the process of its disintegration. These rays are termed alpha, beta and gamma rays. The first products of its disintegration are helium, an inert gas, and radium emanation to which it owes its radio activity. It is to the changes produced by these rays in the tissues that radium owes its therapeutic value. By means of an apparatus perfected by Prof. Duane of Harvard University, it is possible to collect from a sufficient quantity of radium in solution, the emanation, which may be used for therapeutic purposes, and which has all the properties of the parent substance. Radium emanation, a gas, is capable of great concentration. This permits of having in a very small container several hundred times the activity that might be obtained from a similar bulk of the radium salts. This is of tremendous advantage, where radium is to be applied within cavities or where screened or unscreened tubes are to be buried with the tumor substance.

When a small amount of sodium chloride or a piece of lead foil is encased in a glass tube, properly connected with this apparatus, and the emanation is brought and retained in contact with it for three hours, the active deposits radium B and C, which emit beta and gamma rays, will be deposited thereon, rendering the substance temporarily radio-active. The salt may be dissolved in a proper quantity of water to produce a physiological salt solution, its radio activity measured and administered intravenously. Lead foil, when rendered radio-active, in this manner may be cut into the desired shape for the treatment of various superficial lesions.

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To successfully employ radium emanation, an adequate quantity of radium is essential, one gram being approximately the minimum amount that is practical. From each gram of radium in solution, there may be collected each twenty-four hours 166 millicuries, minus a small loss. While the emanation collected undergoes rapid disintegration, losing one-half every four days, and practically all in about twenty days, more is being constantly given off, so that the amount or number of millicuries of emanation available at the end of thirty days is equivalent to the number of milligrams of radium element in solution. It is our rule, unless a special applicator is required, to collect the emanation in small glass capillary tubes, approximately three-fourths centimeter in length and one millimeter in diameter. These tubes are accurately measured to determine their radio activity. By incasing these tubes in various metal capsules, applicators or screens, the character of the beta and gamma rays may be modified as desired.

Extensive studies have greatly increased our knowledge of the histological changes produced by both the beta and gamma rays of radium on normal and pathological tissues. This work, conducted by different investigators, has shown that intracellular changes produced by the radium emanation differ greatly from those produced by the Roentgen rays. All tissues are influenced by a sufficient quantity of radium radiation; however, both normal and pathological tissues vary in their susceptibility, and on certain tissues it seems to exert a definite specific effect. Generally speaking, imperfectly formed tissues and cells are less resistant than normal tissues.

Janeway and Ewing, by a series of investigations, determined that carcinomatous cells were destroyed by one-fourth the dose necessary to destroy a normal epithelial cell. It is this hypersusceptibility of pathological tissues and the selective action upon certain normal tissues that give radium its therapeutic value. If it were possible to approximate a proper dosage, all malignant tissues could be destroyed. While such a technique will probably never be developed, great advancement has, and is being made.

The beta rays of radium with proper dosage have a well-defined and circumscribed effect for an area of approximately one and one-half centimeters, whereas the gamma rays in sufficient quantity, by proper screening and technique, may be effective for a distance of several inches. The beta rays, which are much more abundant, are employed chiefly in superficial lesions of the skin or mucous membrane, where the involvement does not extend beyond one and one-half centimeters in depth, or where the tubes are to be buried within the tumor substance. This, however, includes a very large percentage of the neoplastic diseases that we see.

Where it is desirable to radiate deeper tissues, the beta rays may, with one millimeter of platinum or other proper screening, be absorbed, leaving available the more penetrating gamma rays.

The efficiency of radium therapy depends upon the proper radiation of pathological tissue, with little permanent injury to adjacent normal tissue. Much greater efficiency is obtained from a given amount of radium emanation, where the applicator is buried within the tumor substance. These tubes, buried at a distance of approximately two and one-half centimeters, with proper dosage, produce a homogeneous raying of all intervening tissue. This is a very effective method of treatment. The small size of the emanation tubes makes it possible to bury them, either screened or unscreened, and permits of a large dosage with no sloughing of the tumor and little irritation to normal tissues.

By means of a suitable instrument, the bare or unscreened glass tubes, containing the radium emanation may be imbedded in a tumor, where they are allowed to remain. These tubes gradually lose their activity, remaining active for approximately twenty days. In certain cases where it is desirable to maintain a continuous radiation for a considerable period of time, a number of these tubes with quantities varying from five to ten millicuries may be imbedded at a distance of about one and one-half centimeters. The dosage thus obtained may be computed by multiplying the original amount buried by 132, which gives the total number of millicurie hours dosage.

Frequently we bury the emanation tubes, screened with one-half millimeter of platinum. Here we usually employ larger quantities of emanation, sometimes amounting to several hundred millicuries, and leaving the tube in situ for a few hours, depending upon the dosage desired. There is great advantage in burying the emanation tubes directly into the tumor substance in many locations, particularly in subcutaneous tumors and glands, tumors of the mouth, tongue and pharyngeal space, also in the prostate, bladder and other regions. Through a laparotomy opening, tubes may be buried in tumors within the abdominal cavity. The rapid absorption of various malignant growths, resulting from this method of treatment, has been most striking.

The ease with which either screened or unscreened tubes of radium emanation may be buried within the tissues and the fact that no sloughing or other breaking down of tissue results from proper dosage, render this method applicable in a large number of cases and render entirely unnecessary the opening of tumors by extensive incision, as suggested by Beck and others for the purpose of effecting a radiation of the deeper parts.

In certain cases it is necessary to have a large radio activity, amounting to several hundred millicuries in a very small applicator. This is particularly true in certain locations, where a large dosage is required and where it is difficult to retain an applicator in an accurate position for a long period of time. An emanation tube containing several hundred millicuries, screened with one millimeter of platinum, need not be larger than three millimeters in diameter, by one centimeter in length. This may be placed and retained in the bladder for one hour with little discomfort, using an operating cystoscope and cystoscope

holder. A similar applicator is of great value for application within the larynx, pharyngeal spaces, antrum, nasal fossa and other cavities. Large quantities in small applicators are also of great value, and may be accurately applied within the esophagus, or the cardiac end of the stomach, employing the fluoroscope. Marked palliative results have been obtained in a number of esophageal cases treated. The pain and stricture were relieved, permitting the swallowing of food, with the consequent general improvement.

A short intense radiation, gained from giving a large amount accurately applied for a short period of time, is frequently more effective than the use of a small quantity for a longer period of time. Not infrequently, is it desirable in the course of the treatment of certain cases to combine the various methods described above. The knowledge gained from observing the results in a large number of cases over a considerable period of time, enables one to determine the method of treatment best adapted to each particular case.

The results obtained by improved technique in treating the oral and adjacent cavities have been most encouraging. A high percentage of clinical cures has been effected with little or no disfigurement nor functional disturbances. A certain class of far advanced cases, particularly those with extensive local metastasis, previously considered beyond any treatment, has received marked palliative effect and in some instances, apparently permanent relief.

For the treatment of superficial lesions, radium emanation is ideal, inasmuch as it is possible to make applicators of nearly any desired shape, size and strength, permitting of a uniform and accurate radiation of the lesion. Applicators to conform to the contour of the part are of particular value in treating lesions on the nose, eyelids and lip.

Perhaps in no condition has radium been more generally and deservedly accepted than in uterine bleeding, both benign and malignant. Histological studies of uteri, removed at various intervals after the application of radium, have given us a precise knowledge of the changes produced by different dosage and technique rendering possible the more scientific treatment, which has produced results previously not attained. It is a regrettable fact that the greater amount of radium used in gynecology, is still done on the old standardized method. Benign uterine bleeding may be due to disease of the endometrium, to the presence of tumors or to disturbed ovarian function. Having determined the existing pathology, the technique may be so modified as to effect a proper radiation of the tissue affected.

Benign pathological conditions involving the endometrium are rarely more than one centimeter in depth, therefore when a proper quantity of radium is employed, screened with one-half millimeter of platinum, the effect due to the hard beta rays, which with a dosage of not to exceed 500 millicurie hours, produces the desired changes in the endometrium with little or no injury to the ovaries. This is of particular value in the treatment of menorrhagia in young women, where it is desirable to conserve normal menstruation.

When the pathology is within the uterine wall, as in uterine fibrosis, myomata and fibroids and deeper, or when the uterus is not larger than a three months' pregnancy, the technique and dosage may be so modified as to afford relief of symptoms and a reduction in the size of the uterus, conserving menstruation in a certain percentage of cases where it is desirable to do so.

In women near or past the menopause, and where the uterus is not larger than a four-months' pregnancy or in menorrhagia, due to disturbed ovarian functions, of non-inflammatory origin, radium is still the treatment of choice. When anemia, cardiac lesions or other constitutional disturbances, render the case a poor surgical risk, bleeding may be arrested and the symptoms relieved. In uterine fibroid, where the uterus is larger than a four-months' pregnancy or in menorrhagia or metrorrhagia associated with acute inflammatory conditions, surgical treatment is usually preferable. I am sure that none of us would urge hysterotomy, with its immediate dangers, longer period of invalidism and post-operative sequelae, in a case where radium therapy would yield more satisfactory results.

The results of radium therapy in uterine cancer would alone be enough to establish it as one of our most valuable therapeutic agents. The results obtained in inoperable and recurrent cases together with greater facilities and improved technique have lead to the treatment of earlier cases, until today radium therapy properly applied, is considered by many of the most able gynecologists in this country the treatment of choice in all cases of cervical carcinoma.

In cervical carcinoma, beneficial results are in direct proportion to the earliness with which we see the case. My results are quite consistent with others, whose facilities and technique warrant comparison. In approximately three hundred cases treated during the past four years, clinical cures have been effected in 24% of the inoperable cases, 30% of the recurrent cases and 87% of operable cases, referring to those only in which more than eight months have elapsed since treatment. The foul odorous discharge is arrested, hemorrhage and pain relieved in practically all cases and life prolonged for months and years in a large percentage of cases treated.

The extreme penetration of the gamma rays of radium and their selective effect upon pathological tissues, render them exceedingly valuable for the treatment of deep-seated lesions. For this work, it is necessary, however, to employ large quantities of radium or radium emanation ranging from five hundred to as high as fifteen hundred or two thousand millicuries for a single applicator, and giving at a single dose as much as ten to twenty thousand millicurie hours. By this method we have obtained some very satisfactory results in the treatment of mediastinal growths and other deep-seated lesions, also in conjunction with the direct application in tumors involving the esophagus and the stomach. Somewhat different technique and lesser dosage have been advantageously employed

in the treatment of both primary and metastatic glandular lesions. Over large subcutaneous areas, as in certain types of recurrent carcinoma of the breast, the results are far superior to those obtained by the hard Roentgen rays, and many cases that have progressed rapidly under X-ray treatment, have yielded promptly to appropriate radium therapy.

Hodgkin's disease and leukemia, particularly of the lymphatic and myelogenous type, have been very favorably influenced by the application of large doses of radium emanation. In these conditions, we have frequently buried tubes within the glands and also administered, by means of intravenous injection in solution, the active deposit of radium salts. This undoubtedly hastens the recovery and adds greatly to the permanency of the result.

Time will not permit of a thorough discussion of the internal use of radium and its active deposit, obtained from the radium emanation, but I wish to call your attention to the fact that much work has been done along this line, sufficient to demonstrate its value in properly selected cases of hypertension and arthritis and to encourage more extensive studies.

Post-operative prophylactic use of radium is indicated in a limited number of properly selected cases. Such cases should be the usual early and definitely operable conditions, and the radium used only as an additional safeguard. Following radical operation for breast amputation, radium emanation may be applied through drainage tubes placed at the time of operation directly into the wound. If the tubes are properly placed, a thorough raying of the areas in which recurrence is most frequent may be accomplished. All radiation is given within two or three days, following the operation, when the tubes may be withdrawn and there results little or no interference with the primary healing of the wound. By this or similar technique, radium emanation may be employed in various other locations and conditions.

I would urge very strongly against incomplete surgery or surgery in operable cases, depending upon the post-operative use of radium to effect a cure. Such cases as a rule should much better be treated by radium alone or surgery used only as a means of assisting better approximation of the radium emanation to the involved areas.

In conclusion, I wish to say that I have not endeavored to discuss in detail the many phases of radium therapy, nor even to touch upon the broad scope of this work. It is my desire to simply call your attention to the tremendous advancement that is being made in this branch of medicine, where the work with proper facilities is being scientifically conducted.

I do not hesitate to say that I believe the next few years will see a marked reaction and severe condemnation of radium therapy, due to the fact that very generally, and in increasing numbers, this work is being carried on by men with inadequate equipment and insufficient training and experience. Fortunately, there are in this country a number of substantially endowed institutions, several co-operating with the established cancer research departments of various universities, whose work will stand out and ultimately establish the true value of radium therapy.

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Discussion opened by Dr. Clarence Moore, Los Angeles.

SURGERY OF THE CHEST. *

By CHARLES D. LOCKWOOD, M. D., Pasadena.

The world war has given a great impetus to chest surgery. This youngest of the surgical specialties has grown by leaps and bounds, and already we have an American Association for Thoracic Surgery.

The experience of surgeons in the army hospitals, both in the front areas where battle casualties furnished the bulk of the cases and also in the back areas where infection played the principal role, served to focus attention upon problems fundamental in thoracic surgery.

The organization of army hospitals afforded unusual opportunity for the study of both medical and surgical diseases. Abundance of material, freedom from the distractions of private practice, the constant availability of competent consultants, unlimited laboratory facilities and routine post-mortem examinations created conditions almost ideal for the study of disease. These ideal conditions, however, maintained only in the base hospitals. Evacuation hospitals and mobile hospitals near the front were analogous to emergency hospitals in civil life, and with the exception of a few hospitals, such as Evacuation Hospital No. 1 in France, they did not afford opportunity for completed observation and definitive treatment.

This paper is based upon personal experience in the treatment of gunshot wounds of the chest in front line hospitals and upon observation of the work done by French army surgeons both at the front and in permanent hospitals farther back.

The greatest contribution to the diagnosis and treatment of surgical lesions of the chest were made through routine X-ray examinations and bacteriological studies. X-ray examinations of the chest, in addition to the localization of foreign bodies, revealed unsuspected lung abscesses, encapsulated collections of pus in the pleural cavity and pneumothorax. The French surgeons, notably Robin and Sutro, developed a fluoroscopic method of removing small fragments of shell from the lung which enabled them to remove practically all foreign bodies in the chest with accuracy and only slight trauma. The roentgenographic study of old empyema cavities, outlined with bismuth paste, is a valuable guide to surgical treatment. The contributions of bacteriology to chest surgery is no less significant, and bacteriologic control, combined with frequent radiographic examinations, lends an accuracy to chest surgery comparable to that afforded the genito-urinary surgeon by the cystoscope and the functional tests of the kidney. Bacteriologic control in the treatment of empyema as worked out in the army hospitals has greatly helped to standardize the treatment of this disease.

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